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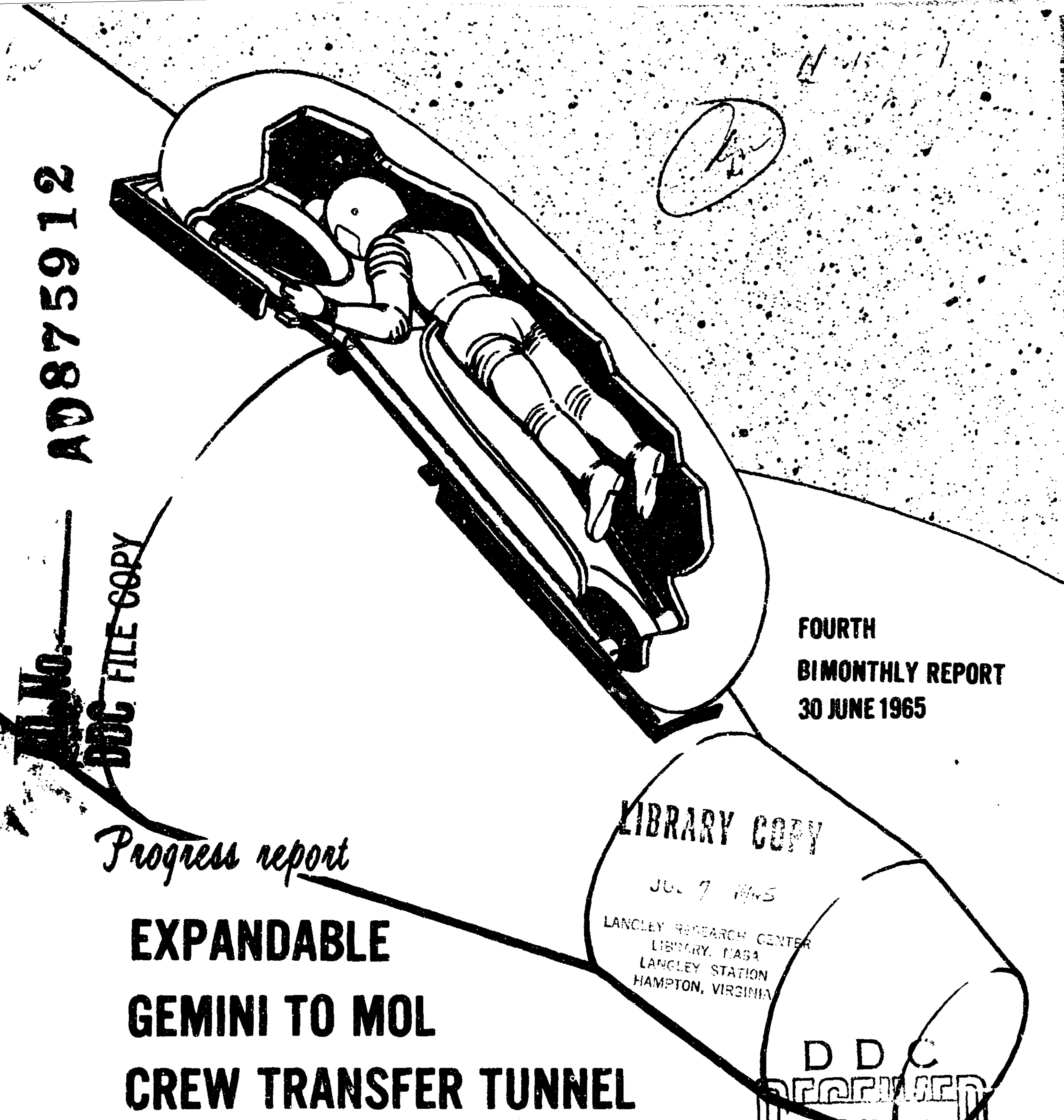

FOURTH
BIMONTHLY REPORT
30 JUNE 1965

Progress report

EXPANDABLE GEMINI TO MOL CREW TRANSFER TUNNEL

CONTRACT AF 33(615)-2114

GOODYEAR AEROSPACE
CORPORATION
AKRON, OHIO

12

CODE IDENT NO. 25500

GOODYEAR AEROSPACE

CORPORATION

AKRON 15, OHIO

FOURTH BI-MONTHLY PROGRESS REPORT

1 MAY 1965 - 1 JULY 1965

EXPANDABLE GEMINI TO MOL

CREW TRANSFER TUNNEL

Contract AF 33(615)-2114

SP-4155

30 June 1965

T. L. Hoffman
Department 455

1-ID-26(7-64)216-52
REF: ENGINEERING PROCEDURE S-017

THIS CONTRACT IS TO DEMONSTRATE THE TECHNICAL FEASIBILITY OF UTILIZING AN EXPANDABLE CREW TRANSFER TUNNEL FOR MOL.

This contractual effort does not indicate that the Manned Orbital Laboratory will actually utilize this crew transfer method. There are several other feasible concepts which may well be utilized by MOL to effect crew transfer.

This contract is funded by Aero Propulsion Laboratory, Directors Discretionary Fund.

I. SUMMARY

This fourth bi-monthly progress report presents the program effort completed during the seventh and eighth months of the modular concept crew transfer tunnel contract period.

Phase II, detail design, analysis, and test has been completed except for some specimen testing. The uncompleted specimen testing consists primarily of tests involving the structural layer of the composite wall, but these tests have been underway for some time and are nearing completion.

Phase III, prototype fabrication and preliminary qualification has been in progress for about four months with work proceeding on the fabrication of the composite tunnel wall, the packaging canister, and the test carrier to support the completed tunnel during testing. The rigid sandwich floor structure has been completed and has been joined to the rigid foam mandrel.

Planning has been coordinated with the Arnold Engineering Development Center (AEDC) at Tullahoma, Tennessee for the expandable tunnel vacuum chamber deployment testing. Agreement has been established on all major areas of concern, with only the date of the Mark I chamber availability unknown. Since the chamber availability for testing is subject to the completion of construction, it is quite probable that the zero "G" flight tests will be performed before the vacuum chamber deployment tests.

II. PHASE II - DETAIL DESIGN, ANALYSIS, AND TEST

The detail design is complete at this time. Joint and seam designs for the structural layer have been finalized, with the designs substantiated by tests. The hardware for attaching and jettisoning the packaging canister has also been finalized. The two parts of the canister will be held together with bolts, and separation of the upper part of the canister, the part restraining the packaged tunnel, will be achieved by using non-gaseous, non-fragmentation guillotines to cut the ten attachment bolts, with the stored energy of the packaged tunnel wall supplying the separation force.

The required thermal coating has been established by analysis, but the finalization of the choice will depend upon the uncompleted environmental testing. The required coating consists of a layer of aluminized Mylar partially covered, probably by striping, by an aluminized silicone paint.

All detail analyses including structural, thermal, meteoroid impact, radiation, and weight analyses have been completed at this time.

The specimen testing program is nearing completion. Micrometeoroid impact tests on stressed composite wall specimens were conducted at the hypervelocity particle impact facility at Wright-Patterson AFB, Ohio during the first week in May. The test results were zero penetration of the structural layer. In fact, there was absolutely no damage to the structural layer when a micrometeoroid barrier of two inch thick polyether flexible foam with a density of one pound per cubic foot was used. The particles used were Mylar discs of

approximately 5 milligrams travelling at an average velocity of about 27,000 feet per second. In these tests, the two inch flexible foam barrier proved to be 16 times as effective as single sheet aluminum on the basis of weight per unit surface area.

The uncompleted specimen testing consists primarily of tests involving the structural layer of the composite wall, the thermal coating, and the abrasion characteristics of the astronaut's space suit relative to the tunnel interior surface. The tests involving the structural cloth have been underway for some time and are nearing completion. Testing of candidate thermal coatings has also been initiated but has not been completed. The abrasion tests have not been started because samples of the space suit material have not as yet been obtained.

The guillotines to be used for cutting the canister attachment bolts have been received, and they will be tested the first week in July under ambient conditions at GAC. Three of the guillotines will be sent to AEDC for test firing in a vacuum chamber to insure operational reliability for the vacuum chamber deployment testing of the expandable tunnel.

III. PHASE III - PROTOTYPE FABRICATION AND PRELIMINARY QUALIFICATION

The rigid foam mandrel has been completed, and the rigid sandwich floor structure has been completed. The floor has been sealed and covered by a laminate of nylon cloth and 0.070 inch closed cell vinyl foam pressure

bladder material. Both the mandrel and the floor have been assembled to the fabrication support fixture, and the multi-ply pressure bladder part of the composite wall has been fabricated on the mandrel and bonded to the sealed floor. Forming fixtures were fabricated for the stretch forming, under heat and vacuum pressure, of the film-cloth and cloth-foam laminates of the pressure bladder where the fabrication patterns required double curvature at the hemispherical ends and torus cross-sections of the tunnel wall. Stretch-forming of the double-curvature patterns was required in order for the patterns to fit the contour of the mandrel and not wrinkle at the pattern seams. The forming process will also be used for the film-cloth laminate outer cover of the composite wall.

The dacron cloth purchased for the structural layer of the composite wall is a substitute cloth, the purchase of which was necessitated by the long lead time required by the mill to supply the desired cloth. Tests of the purchased cloth have established that a safety factor of 5 is achieved, based on design geometry and the design pressure of 7.5 psi, but neglecting creep-rupture effects due to 60 days loading at the design pressure. In view of the fact that the tunnel is a prototype model which will not be subjected to 60 days loading, and also that the safety factor of 5 is high for ambient usage, the utilization of the substitute cloth is deemed satisfactory.

Also in view of the long lead time required, a substitute paint will be used for the thermal coating. The thermal analysis indicates that the thermal

coating required consists of a layer of aluminized Mylar partially covered, probably by striping, by an aluminized silicone paint. In view of the fact that this paint is white, the substitute paint purchased to simulate the required thermal coating is white hypalon paint.

Fabrication of the packaging canister has been started and is proceeding satisfactorily. The final assembly of the canister, which is being made in two parts to achieve the desired method of separation and ejection, will not be performed until the completion of the packaging tests on the expandable tunnel. The reason for this approach to the canister final assembly is to achieve the lowest possible packaging height relative to the rigid sandwich floor.

Fabrication of the test carrier to support the expandable tunnel during in-house testing and vacuum chamber testing has been initiated and is also proceeding satisfactorily. The test carrier incorporates equipment required for proof-pressure testing, leakage testing, cyclic pressure testing, and vacuum chamber deployment testing. All the equipment required has been either received or ordered. Fabrication has also been started on the vacuum chamber penetration plates required by the AEDC facility at Tullahoma. All testing procedures and equipment requirements for the vacuum chamber testing have been coordinated thus far with the AEDC facility. A preliminary test plan for the vacuum chamber testing is presently being prepared for approval by AEDC personnel.

Conceptual designs of two expandable structures experiments applicable to the MOL have been prepared and submitted to RTD at Wright-Patterson AFB for study. One experiment is an expandable airlock which may be used for an exit and entrance to MOL for extra-vehicular activity. The airlock has four transparent viewports so that it may also be used as an observation post for extra-vehicular activity or may be used for viewing other space objects or events. The other experiment is an expandable space maintenance hangar that may be used for the assembly and operation of other MOL experiments. The space maintenance hangar has an operating inflation pressure of 3.5 psia with a packaged weight of 2,000 lb. and an operational weight of 1,500 lb. The airlock has an operating inflation pressure of 7.5 psia with a packaged weight of 205 lb. and an operational weight of 125 lb.

GAC is also preparing a third conceptual design of an expandable structures experiment which is beyond the scope of the contract, but which GAC feels would be a valuable addition to the MOL program. This structure is also a space maintenance hangar concept, but it provides docking facilities for the Gemini-MOL vehicle with an expandable structure to enclose the entire vehicle to protect astronauts performing maintenance or repairs on the Gemini-MOL vehicle. This conceptual design will be submitted to RTD for study in the very near future.

IV. GENERAL STATUS AND NEXT REPORTING PERIOD

The general status of the contract program is very good. At the present time no major problem areas are apparent, and except for the vacuum chamber deployment testing, the program is on schedule. The date of the AEDC Mark I vacuum chamber availability is presently unknown, but in all probability, the zero "G" flight tests will be performed before the vacuum chamber deployment tests.

Phase I, the concept definition, has been completed, and Phase II, the detail design, analysis, and test complete except for a small amount of specimen testing. Phase III, prototype tunnel fabrication and preliminary qualification, has been in progress for approximately four months and is proceeding on schedule. The rigid foam mandrel and the rigid sandwich floor structure have both been completed. The floor has been sealed, attached to the fabrication fixture, and bonded to the pressure bladder which was fabricated on the mandrel. Fabrication is proceeding satisfactorily on both the packaging canister and the test carrier for supporting the expandable tunnel during testing. The testing procedure to be followed has been finalized, and all required equipment is being fabricated or has been ordered. The two conceptual designs of expandable structures experiments applicable to the MOL, the airlock and the space maintenance hangar, have been submitted to RTD.

During the next reporting period, program effort on Phase II, of which only specimen testing remains, will be completed. Phase III will also be completed except for the vacuum chamber deployment testing. The remainder of the composite wall of the tunnel will be fabricated and the rigid foam mandrel will

be removed. The fabrication of the packaging canister and the test carrier will also be completed. All testing except the vacuum chamber deployment testing will be completed. These tests include packaging, proof pressure, leakage, and cyclic pressure tests. The tunnel will be evaluated from the human factors standpoint and the lighting and locomotion aids will be installed. The tunnel will be delivered to RTD for zero "G" flight testing at the end of the reporting period. A preliminary design will be prepared of the selected expandable structures experiment concept.

The fifth program briefing was held the third week in June at GAC. In order that RTD might plan further program briefings at GAC, the planned fabrication and preliminary qualification testing schedule is described below.

The structural cloth layer and the structural floor joint of the tunnel composite wall will be applied during the week of 5 July 1965, and the polyether foam meteoroid barrier and outer cover laminate will be applied during the week of 12 July 1965. The thermal coating, the substitute hypalon paint, will be applied and the rigid foam mandrel will be removed during the week of 19 July 1965. Final assembly of the tunnel and the attachment of the tunnel to the test carrier will be performed during the week of 26 July 1965.

Preliminary human factors evaluation and temporary installation of the lighting and locomotion aids will be done during the week of 2 August 1965. Packaging tests and final assembly of the packaging canister will be performed during the week of 9 August 1965. Proof pressure and leakage tests will be performed

during the week of 16 August 1965. GAC plans to run these test concurrently, monitoring the leakage at the proof pressure of 10 psig for 7 days. The leakage at 7.5 psig can then be determined as a direct proportionality of the inflation pressures relative to the leakage at proof pressure. This procedure will allow the week of 23 August 1965 to be used for cyclic pressure testing and further human factors evaluation with final installation of the tunnel lighting and locomotion aids before shipment to RTD at the end of the week.

T. L. Hoffman

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Project Engineer
Goodyear Aerospace Corporation
Department 455

TLH/emg

[illegible] 1 Apr 65, 1v. Rept no. SP-

[illegible] 2134

Unclassified report

Descriptors: (*Space capsules, Spacecraft [illegible], (*[illegible] docking, Expandable [illegible], Rendezvous spacecraft, Feasibility studies, Space crews, Manned spacecraft, [illegible], Space stations, Modular space [illegible], Hatches, Attachment, Thermal [illegible], Shielding, Pressure vessels, Honeycomb cores, Expanded plastics, Structures, Design, Construction, Scheduling, Models (Simulation))

The program effort is now directed toward the design and [illegible] of the modular concept crew transfer tunnel. Phase II detail design, analysis, and test has been in progress for four months with work proceeding satisfactorily in all three areas. Details of the present state of the design, including structural design details, material properties and test results, are shown in Appendix A, Summary Presentation, which was presented at SSD on 20 April 1965. The detail design is approximately 90 percent complete at this time, and definite design requirements have been established for the remaining 10 percent. Detail analyses including structural, thermal, meteoroid impact, and radiation are being performed, and all except the thermal analyses are virtually completed. Specimen testing for vacuum, ultraviolet, toxicity, permeability, thermal, micrometeoroid impact, and radiation is being conducted, but is not completed. Micrometeoroid impact tests on unstressed composite wall specimens showed absolutely no damage to the structural layer. (Author)

AD-468 59[illegible] Div. 12/6 ,30/1 ,12/1 ,12/2 [illegible]
[illegible] CORP SANTA MONICA CALIF
PROGRAM BUDGETING FOR SPACE ACTIVITIES,

by M. A. Margolis, and S. M. Barro. Aug 65, 30p. Rept. no. RM-4690-RC

Unclassified report

Descriptors: (*Spacecraft, Research program administration), (*Space flight, Federal budgets), (*Federal budgets, Spacecraft), Management planning, Scientific research, Manned spacecraft, Department of Defense, Costs, Economics

This Memorandum represents one chapter in a forthcoming book, Program Budgeting: Program Analysis and the Federal Budget. This chapter [illegible] application of program budgeting [illegible] to the national space program. It reviews current and future activities of the federal agencies that participate in the space program, identifies certain program characteristics that will facilitate the introduction of program budgeting, and discusses other characteristics—notably interdependence among space projects—that may present difficulties. The nature of space program objectives and their relationship to missions and program budget categories are examined in detail. Specific suggestions are made about the steps to be taken to convert from the existing budget to a program budget format and some of the analytical applications of a space program budget are mentioned. (Author)

AD-468 6[illegible] Div. 12/6 ,12/2 ,5/2
LINCOLN LAB MASS INST OF TECH LEXINGTON
DIVISION 6, SPACE COMMUNICATIONS.
Quarterly technical summary, 1 Mar-31 May 65, [illegible] Dinneen. 15 Jun 65, 36p. Contract AF 19(628)500 Proj 649L
ESD [illegible] TDR-65-2[illegible]

Unclassified report

Descriptors: (*Space communication systems, Satellites (Artificial)), (*Satellites (Artificial), Space communication systems), Reports, Stabilization systems, Scientific satellites, X band, Transponders, Magnetism, Torque, Digital systems, Performance (Engineering), Telemeter systems, L band, Spheres, Programming languages, Radar, Space probes, Radar antennas, Communication satellites (Active), Communication satellites (Passive)

This summary includes the work of all groups within Division 6, Communications, with the exception of work on seismic discrimination in Groups 64 and 65, which is reported directly to the sponsor in a different form. It also reports on portions of the Space Communications Program undertaken by Division 3, Radio Physics; Division 4, Radar; and Division 7, Engineering. The launch of the second Lincoln Experimental Satellite (LES-2) occurred on 6 May 1965 from Cape Kennedy. The Titan III A carried LES-2 into a circular orbit from which a booster rocket was fired, placing the satellite into an elliptical orbit of apogee at 8000nm and perigee at 1500nm. LES-2 contained an all solid state X-band transponder, a switched antenna system with earth sensing by means of visible light, and an automatic magnetic torque to control spin-axis orientation. An additional feature of the 6 May launch was the placement, in an 1500-nm circular orbit, of the 1.0-m2 Lincoln calibration sphere which can serve as a standard calibration target for many space radar and space communications facilities throughout the world. The LET was completed during this quarter and was used for digitized, vocoded voice transmissions with LES-2. (Author)

AD-468 680 Div. 12/6 ,12/3
MARTIN CO DENVER COLO
DETAIL SPECIFICATION FOR STANDARD SPACE LAUNCH VEHICLE STANDARD CORE.
1 Jun 65, 157p. Rept. no. SSS-TIII-D-SLV/01A010
Contract AF04 695 150

Unclassified report

Descriptors: (*Launch vehicles (Aerospace), Specifications), Performance (Engineering), Design, Systems engineering, Weight, Quality control, Standardization, Military requirements, Test methods, Packaging, Booster motors, Second-stage motors, Third-stage motors, Flight control systems, Pressure, Pneumatic systems, Attitude control systems, Power supplies, Instrumentation, Safety, Inertial guidance, Malfunctions, Detection

The Standard Core when assembled in proper combination with other contractor furnished end items and government furnished equipment provides a means of launching a variety of spacecraft payloads, either manned or unmanned, into various sub-orbital trajectories, space orbits, or escape flight paths. The Standard Core is the primary end item of the Standard Space Launch Vehicle, SLV-5 system. (Author)

AD-468 792 Div. 12/6 ,12/1
AIR FORCE FLIGHT TEST CENTER EDWARDS AFB CALIF
THE HYPERSONIC LATERAL-DIRECTIONAL DYNAMICS OF LIFTING REENTRY VEHICLES.
Final technical rept.,
by Robert W. Kempel. Aug 65, 19p. Rept. no. AFFTC-TR-64-46

Unclassified report

Release or announcement to foreign governments or their nationals is not authorized.

Descriptors: (*Reentry vehicles, Lift), (*Spacecraft, Lift), (*Hypersonic test vehicles, Lift), Flight testing, Aerodynamic characteristics, Roll, Pitch (Motion), Yaw, Partial differential equations, Stability

The linear lateral-directional characteristic equation (transfer function denominator) and mode response ratios for hypersonic lifting reentry vehicles were derived. Three forms of the equations were considered: (I) a complete form, (II) a form neglecting the product of inertia, and (III) a form neglecting the product of inertia and the cross and damping derivatives. Approximate factors which can be used to solve the various forms of the characteristic equation are presented. The various forms of the equations were solved for several lifting reentry vehicles. The results indicate that the equations in their simplest form (Case III) can be used in determining important characteristics of hypersonic reentry vehicles. From the simplified equations (Case III) accurate expressions for the lateral-directional oscillatory (dutch roll) frequency and modal response ratios can be determined. A relatively simple method for determining the effective-dihedral and directional-stability derivatives from flight test records is provided in a form which will be useful in dynamic analysis of lifting reentry vehicles. (Author)

AD-468 941 Div. 12/6 ,12/1
ROYAL AIRCRAFT ESTABLISHMENT FARNBOROUGH (ENGLAND)
PERTURBATIONS OF SATELLITE ORBITS BY THE GRAVITATIONAL ATTRACTION OF A THIRD BODY.
Technical rept.,
by Myrna M. Lewis. Jun 65, 19p. Rept. no. TR-65118

Unclassified report

Descriptors: (*Orbital trajectories, Gravity), (*Perturbation theory, Satellites (Artificial)), N-body problem, Elliptical orbit trajectories, Mathematical analysis, Great Britain, Equations

Equations giving the rates of change of the six orbital elements of a close satellite due to the gravitational attraction of a third body are derived using Lagrange's planetary equations. Modified expressions are also given for evaluating the perturbations when only first order terms in the eccentricity of the disturbing body are retained. (Author)

AD-468 973 Div. 12/6
AEROSPACE CORP EL SEGUNDO CALIF
DIGITAL SIMULATION FOR SATELLITE ATTITUDE DETERMINATION AND CONTROL.
by V. A. Chobotov. Aug 65, 1v. Rept. no. TOR-669(6540)-1
Contract AF04 695 669

Unclassified report

Supersedes Rept. no. ATM-65 (5101-02)-27 dated 8 Jun 65 and Rept. no. ATM-65 (5128)-50 dated 26 May 65.

Descriptors: (*Satellite attitude, Simulation), Partial differential equations, Yaw, Pitch (Motion), Roll, Torque, Solar radiation, Magnetic fields

Equations of motion have been derived for attitude determination and control of a multiplepart vehicle in orbit. The vehicle may consist of an arbitarary number, mass distribution, location and motion of parts such as the control moment gyros, reaction wheels, gas jets, etc. In an effort to minimize computer programming complexity, the equations have been written in vector, scalar and matrix forms. The various environmental perturbations such as the gravitygradient, magnetic torque, solar radiation and aerodynamics are derived in terms of the vehicle parameters and its attitude matrix. The attitude matrix determination is carried out with the aid of the Euler parameters, while the input and output variables are the Euler angles. Appendix A "described the computation of the satellite inertia dyadic. Appendic B describes the application of the equations for a three-body gravity-gradient stabilized satellite of the vertistat type. Appendix C applied the equations to a control-moment gyro-damped system. (Author)